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Compliance Guide for the Concentrated Aquatic Animal Production Point Source Category

Chapter 14: Feed Management for Net Pen Facilities

Full document available at
http://www.epa.gov/waterscience/guide/aquaculture

Engineering and Analysis Division
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U.S. Environmental Protection Agency

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Feed Management

Waste feed and feces constitute the major portion of the wastes generated by net pens. However, because net pens operate in high-energy, open water environments (where they are exposed to currents, waves, and storms), the concentration and collection of wastes is difficult.

The most effective way to reduce the discharge of solids from net pen systems is effective feed management. Effective feed management is based on two components: waste reduction and optimal feed conversion ratio. Waste reduction focuses on ensuring that feed used by the farm is not lost or discharged prior to intake by the aquatic animal. Optimal conversion focuses on ensuring that all feed intake offered to the aquatic animal is actually consumed and optimally digested and used by the aquatic animal.

Documenting efficient feed management for EPA may be achieved by describing the following in your BMP plan:

- Feed methods used to minimize solids production.
- Modifications made to feed quantities as fish production changes (e.g., size, health of fish).
- Feed handling methods used to reduce generation of fines.
- Feed formulations information for each life-history stage of fish reared.

Examples of Feed Management Practices

1) Calculate feed conversion ratios by using feed and aquatic animal biomass inventory tracking systems 

Calculation of feed conversion ratios (FCRs) is an essential function on all net pen farms. Monitoring long- and short-term changes in feed conversion ratios allows farmers to quickly identify significant changes in feed consumption and waste production rates. Refer to Appendix N for an example log to calculate and track FCRs.

2) In cooperation with feed manufacturers, seek to minimize nutrient and solids discharges through optimization of feed formulations 

Feeds should be formulated for optimum feed conversion ratios and retention of protein (nitrogen) and phosphorus. Feed formulations should consider numerous factors including, pellet stability, digestibility, palatability, sinking rates, energy levels, moisture content, ingredient quality and the nutritional requirements of the species being grown. Feeds should be formulated and manufactured using high-quality ingredients. Feed ingredients should have high dry matter and protein apparent digestibility coefficients. Formulations should be designed to enhance nitrogen and phosphorus retention efficiency, and reduce metabolic waste output. Feeds should contain sufficient dietary energy to spare dietary protein (amino acids) for tissue synthesis. Feeds should be water stable for sufficient periods such that pellets remain

intact until eaten by fish. Questions regarding feed formulations should be referred to a qualified fish nutritionist or feed manufacturer.

3) Experiment with feed formulations designed to reduce the total environmental impact of the feed NET

If experimental formulations that use alternative protein and lipid sources are tried, care should be taken to ensure that digestibility is not decreased and the nutritional needs of the species being cultured are met. Farmers should be careful that alternate formulations do not increase feed conversion ratios, decrease fish growth, and result in increased fecal waste.

4) Use efficient feeding practices NET

Feed can be delivered by hand, demand feeders, automatic feeders, or by mechanical feeders. Regardless of the delivery method or system, the amount of feed offered should optimize the balance between maximum growth and maximum feed conversion efficiency. The appropriate quantity and type of feed for a given species is influenced by aquatic animal size, water temperature, dissolved oxygen levels, health status, reproductive status, and management goals. Feed particle size should be appropriate for the size of aquatic animals being fed. Feeding behavior should be observed to monitor feed utilization and evaluate health status.

5) Check feeding equipment to ensure efficient operation NET

Improperly adjusted or malfunctioning feeding equipment can over-feed or under-feed fish and reduce feed and production efficiency.

Figure 14.1. Automatic feeder for net pens

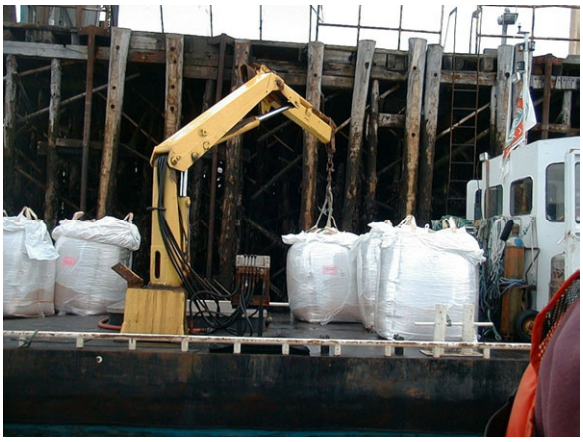

Figure 14.2. Feed handling for net pens

6) Reduce fish stress and optimize culture conditions to reduce FCRs NET

Facilities can reduce fish stress by avoiding overcrowding in production systems and maintaining and cleaning net pens to make sure adequate water can move through the nets. Remember to properly clean your nets to avoid harm to the environment.

7) Conduct employee training in fish husbandry and feeding methods to ensure that workers have adequate training to optimize FCRs 

Additional information about performing training is available in "Chapter 13: Perform Training for Flow-through, Recirculating, and Net Pen Facilities."

8) Wherever practical, use monitoring technologies such as video, "lift-ups," or digital scanning sonar sensors to monitor feed consumption and reduce feed waste


If automated feeding systems are used, fish monitoring systems should, if possible, be actively linked to feeding control systems to provide direct control feedback to reduce feed wastage. Even if monitoring systems are employed, active monitoring by farm operators should also occur to ensure that all systems are functioning properly and aquatic animals are behaving and feeding normally.

9) If water depths and currents allow, regularly examine the bottom under net pens and cages 

To prevent benthic impacts from occurring, close attention should be paid to the presence of any waste feed and how the benthic environment appears to be assimilating the nutrient load. Regular inspections by divers or video cameras can alert farm operators to potential problems before they become unmanageable. Also, use information collected by third parties or regulators to adjust management practices if necessary.